Exhibit B

TECHNICAL SPECIFICATIONS
AUTOTRANSFORMERS 105/140/175 MVA
DEARMIN SUBSTATION

PART 1 - GENERAL

1.01 WORK INCLUDED

This section supplements Exhibit A – General Requirements and provides technical design information for the manufacture, assembly, accessories, factory test requirements and operating requirements for high-voltage type outdoor oil-immersed autotransformer.

1.02 RELATED SECTIONS.

Related sections are Exhibit A– General Requirements.

1.03 TRANSFORMER CAPABILITY

A. The transformer unit shall be capable of transforming its self-cooled rating continuously, oil to air, at rated voltage and frequency without exceeding a temperature rise of 55ºC. The transformer shall be equipped with two stages of automatic, forced air auxiliary cooling equipment which shall increase its self-cooled rating to the levels stated with the auxiliary cooling equipment in service and without exceeding a temperature rise of 55ºC. The transformer shall be insulated to permit safe operation at not less than 65ºC with increased thermal operating capacity of not less than 12%.

B. The impedance of the transformers shall be based on the self-cooled rating (55ºC).

1.04 TRANSFORMER RATING

A.	Number of Phases	Three
B.	Coolant	Insulating Oil
C.	Type	ONAN/ONAF/ONAF (See item 1.04)
D.	Frequency	60 Hz.
E.	Winding Impedances	7.5% @ 105 MVA with ± 3%
F.	Capacity	105/140/175 MVA (Main Windings) (Tertiary Winding: 35% of largest MVA or common winding).
G.	High Voltage Winding Rated Voltage	230 kV Grd. Wye.
H.	Low Voltage Winding Rated Voltage	67 kV Grd. Wye.
I.	Tertiary Winding Rated Voltage	13.2 KV (Delta)
J.	Full Rated Taps	As specified hereafter above and below rated voltage, manual for de-energized operation; and automatic for load tap change operation.
K.	Basic Insulation Level (BIL)	High Voltage – 750 KV

		Low Voltage – 350 KV Tertiary Voltage - 110 KV HOXO Neutral Voltage – 110 KV
L.	Avg. Temperature Rise	105/140/175 MVA at 55°C, l additional 12% capacity (117/157/196 MVA) at 65°C.
	1. Hot Spot	55°C Rating - 65°C
	2. Hottest Spot Temperature	65°C Rating - 80°C
M.	Duty	Continuous
N.	Phase Displacement	IEEE Standard C57.12.00 (Typical)
O.	Sound Level	Shall not exceed: 77 db @ 105 MVA 79 db @ 140 MVA 80 db @ 175 MVA (5 db below NEMA TRI-1974)

As a preference, Ocala Electric Utility prefers ONAN/ONAF/ONAF. It is recommended that the base bid incorporate a transformer of this type. However, if the bidder believes a different design would be to the mutual interest of the Bidder and the Utility, it is recommended that you bid an alternate, incorporating the alternate method of cooling you prefer.

1.05 TYPE AND SERVICE

A. The Autotransformer will be used as a connection point from a 230 KV transmission line to supply bus for a looped transmission system at 69 KV. The neutral of the transformer will be solidly grounded.

B. Available control power from the existing battery bank is 130 VDC.

1.06 SHORT CIRCUIT REQUIREMENTS

A. The transformer shall be designed and constructed to be completely self-protected by its ability to withstand, without mechanical damage, the effects of external short circuits, as specified in IEEE C57.12.00, Section 7, IEEE C57.12.90, Section 12 and IEEE C57.109. The leakage impedance measured after the test series shall not differ from that measured before the Test series by more than two percent of its former value.

B. The transformer test data shall include proof of circuit design considerations by short circuit calculations. The calculations shall include electrical and mechanical forces.

C. Short circuit force values shall include, but not be limited to, short circuit amperes, repulsion force in pounds and vertical force in pounds.

D. Mechanical safety factors used in design of hoop strength of the outer winding, buckling strength of the inner winding, core clamp strength, vertical bar strength, clamping ring strength and jackscrew strength.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

Materials and equipment shall comply with the requirements of Exhibit A – General Requirements.

2.02 TANK

The transformer tank and base are specified in Exhibit A – General Requirements.

2.03 CORES

A. Cores shall be assembled and tested to conform to the requirements of ASTM 712, with core losses limited per ASTM A 343.

B. The transformer shall be free from unusual or harmful vibration. Lifting eyes or lugs shall be provided for handling the core assemblies when un-tanked.

C. The core laminations shall be free of burrs and shall be stacked using modern joint design to provide uniform flux density and magnetic reluctance over the joint region. The lamination insulation coating shall be impervious to hot insulating transformer oil.

D. The core shall be rigidly clamped with the electrical centers of all coils in line to prevent deteriorating vibrations, interference with oil circulation, objectionable noise conditions, and short circuit and shipment distortions. The core shall be securely grounded externally on the tank. The core ground lead shall be brought out through the tank cover, or through the side of the tank close to the cover, with a 5 KV insulated bushing.

2.04 WINDINGS

A. The transformer windings insulation level shall conform to the latest requirements of IEEE C57.12.00 Table 5, as follows:

1. *High Voltage Requirement*

a.	Voltage Class	230 KV
b.	Low Frequency Test	325 KV
c.	BIL	750 KV
d.	Chopped Wave Impulse Test	825 KV

2. *Low Voltage Requirement*

a.	Voltage Class	69 KV
b.	Low Frequency Test	140 KV
c.	BIL	350 KV
d.	Chopped Wave Impulse Test	385 KV

3. *Delta Tertiary Voltage Design*

a.	Voltage Class	15 KV
b.	BIL	110 KV

4. *HOXO Neutral Voltage Design*

a.	BIL	110 KV.

B. The transformer windings shall be designed and tested to withstand impulse test voltages in accordance with IEEE Standard C57.12.00. The windings shall be made of copper and assembled in a manner as best suited for the application. Proper consideration shall be given to all factors of service such as high dielectric and mechanical strength of insulation, coil characteristics, and minimum restrictions to free circulation of oil. Coils shall be made up, shaped, and braced to provide for expansion and contraction due to temperature changes in order to avoid abrasion of insulation and to resist movement and distortion caused by abnormal operating conditions. Adequate barriers shall be provided between windings and core, and between high-voltage and low-voltage windings. End turns or section of coils shall have additional insulation protection against abnormal line disturbances. The entire design, construction, and treatment of the windings and their assembly on the core shall embody the latest improvements in the art and conform to best modern practice.

C. An insulation system suitable for an average winding temperature rise by resistance of 65°C shall be used.

D. The autotransformer shall have the primary to secondary autotransformer winding wye connected and shall be designed for a power supply of 230,000 to 67,000 volts, nominal. Rated KVA taps shall be provided as stated in Section 1.04.

E. The tertiary winding shall be suitable for 13.2 KV operation. This delta tertiary stabilizing winding shall be connected in Delta and shall be rated to make the winding self-protecting. The stabilizing winding shall be brought out on four bushings; two of these bushings shall be used for external closing of the Delta and shall be suitable for operating with this corner of the Delta grounded. Deviation from this requirement shall be so stated in the proposal.

F. The phase-to-neutral voltage of the high voltage winding shall lead by 30° phase-to-neutral voltage of the tertiary winding.

G. The components of the transformer shall take into account the increased capacity allowed by the 65° insulating system and the ability of the transformer to operate at the higher temperature shall not be limited by any ampacity or other limitations.

2.05 INSULATING OIL

Insulating oil and oil preservation equipment are specified in Exhibit A, Appendix 1.

2.06 TAP CHANGER REQUIREMENTS

A. Manual Tap Changer:

1. A manual tap changer shall provide for full capacity range of plus 5% and minus

5% in two steps of 2 ½ % above and below the middle tap position for the particular voltage rating at taps of 241,500; 235,750; 230,000; 224,250 and 218,500 volts.

2. The high voltage windings shall be nominally rated for 230 KV. The low voltage windings shall be capable of delivering 67 KV Wye with grounded neutral.

3. The handle for manual operation of the tap changer for De-energized operation shall be brought out through the tank wall and must provide adequate clearance from any energized part. Preferably the handle shall be located at not more than five (5) feet above top of concrete pad, but may be located at greater height above top of concrete pad if in accordance with manufacturer's standard design. Provisions shall be made for padlocking the handle in the chosen position and for positive visual tap position indication without unlocking. A stainless steel nameplate, which states **"WARNING - Do Not Operate This Tap Changer When Transformer is Energized**", shall be permanently attached to the tank located next to the operating handle. Screws, if used to attach nameplate, shall be stainless steel. This nameplate shall be shown on the outline drawing. This tap changer shall be referred to on the nameplate and at the tap changer handle as "DEENERGIZED TAP CHANGER".

B. Automatic Load Tap Changer (LTC) and Controls:

1. LTC shall be as manufactured by Reinhausen - type RMV-II. (No substitutions).

2. Automatic LTC equipment shall be provided for automatic operation of the low voltage taps and shall provide approximately 10 percent plus and 10 percent minus adjustment of the voltage rating of the low voltage windings. The voltage change shall be in approximately 5/8 percent steps with 16 steps above and 16 steps below rated low voltage.

3. The LTC equipment shall be designed to provide regulation of the low voltage winding, maintaining full capacity KVA at all tap positions above rated voltage and not less than rated current at all tap positions below rated voltage.

4. LTC Windings

    a. The regulating winding shall be electrically independent or placed on a separate winding tube from the high and low voltage windings and shall be fully distributed.

    b. Preventive auto and series transformers, if required, shall be constructed to Class 2 autotransformer standards including circular core and coil design and disc or helical type winding construction, using all copper conductors.

5. The LTC equipment shall consist of a tap selector with vacuum interrupting switch, a motor-driven mechanism, and automatic and manual control devices. The LTC equipment shall be capable of a minimum of 500,000 operations before contact replacement is required. A dead-front operating panel shall be provided whereby the gears and mechanism are covered. Only Beckwith #M2001C solid state control with all associated paralleling equipment is acceptable unless specifically identified as an exception and approved in writing. If fuses are used in the control circuits, two sets of spare fuses for each transformer shall be provided by the Contractor and one set shall be stored in a suitable clip next to the control panel.

    a. The LTC mechanism drive motor shall be located at operator height, if possible, for ease of maintenance and replacement. Draining of the LTC compartment shall not be required for access to the drive motor.

6. LTC operating unit will be reactance vacuum type.

7. Local position indicator shall be calibrated L (lower) - N - R (Raise) from the left end to the right end of the scale. Position indicator shall be located so that it will be visible to an operator at the control switch for the drive motor.

Indicator shall be mechanically driven directly from the drive mechanism without auxiliary devices. Drag hand shall be reset electrically by pushbutton located in the Transformer Control Cabinet.

a. A stainless-steel nameplate shall be permanently mounted on the outside of the control cabinet housing the manual raise and lower controls so an operator can identify the LTC control housing. A duplicate nameplate shall be mounted inside the cabinet next to the raise and lower controls. The nameplates shall state: "LOAD TAP CHANGER –for Operation with Transformer Energized and Carrying Load". Screws, if used to attach nameplates, shall be stainless steel. The nameplate shall be shown on the outline drawing. The nameplates shall include the following information:

    1. Manufacturer of the mechanism.
    2. Model number of the mechanism.
    3. Year of manufacture.
    4. Maximum rated through current of the mechanism.
    5. Type of transition impedance.
    6. Method of arc interruption (type of mechanism).
    7. Type of drive mechanism, direct or energy spring.
    8. Amount of oil in the mechanism compartment.

8. The LTC equipment shall be suitable for, completely equipped and wired for continuous parallel operation with similar transformers. The Contractor's drawings shall provide complete wiring & schematic diagrams for parallel operation.

9. The automatic LTC equipment shall include:

    a. A voltage regulating relay and line drop compensator.

    b. The load tap changer shall be provided with a 17-position switch with 16–80-ohm resistors or with a 33-position switch with 32–40-

ohm resistors for tele-metering of tap position. The switch shall be mechanically connected to the tap changing mechanism and is to switch the taps of the resistor and the moving contacts of the switch are to be wired to terminal blocks for the Owner's remote connections. The circuit is to be insulated for 125 VDC operation. Limit switch and stops to prevent travel beyond extreme tap positions shall be provided.

c. Auxiliary control.

d. Current transformer for the line-drop compensator with a 0.2 ampere or other suitably rated secondary.

e. Reversing switch for reactance portion of the line-drop compensator.

f. Auxiliary current transformers to permit parallel operation by the circulating current method with other units in the same substation.

g. Provisions for Owner's wiring for supervisory control of the LTC equipment.

h. All other features standard on manufacturer's LTC equipment.

i. Note: It shall be possible for others to install complete supervisory control and indication. All necessary terminals, etc., shall be provided at this time. Drawings indicating modifications required and facilities provided as part of original manufacture shall be provided.

10. Control equipment shall be mounted in a NEMA 4X (304 stainless steel) suitable outdoor weatherproof compartment on the transformer, designed to provide protection against windblown dust and rain. The control equipment shall be accessible by an operator at ground level and shall be a maximum of 5 feet above top of concrete pad. The control equipment shall include the following:

a. Remote-Local switch for enabling remote LTC Raise-and-lower operations from control building panel.

b. Raise-and-lower switch for manual control at the transformer.

c. Selector switch for automatic or manual control of the LTC.

d. Selector switch for independent or parallel operation.

e. Position indicator with drag hands to indicate maximum tap position travel, with electrical reset in control cabinet.

f. On-position indicator.

g. Electrically actuated operation counter in cabinet.

h. Power supply switch.

i. Resistors mounted and wired to an analog transducer producing a 4-20ma output connected to an SEL-2414 for position indication. (See Paragraph 2.06.B.9.b)

j. Hand-wheel for use during maintenance, interlocked with motor control.

k. Light and G.F.C.I. convenience outlet.

l. 120 or 240 VAC space heaters and fused switch with personnel barrier.

m. Local voltmeter test connection.

11. The tap selector switch and contactor mechanisms shall be located in a compartment mounted on the transformer and filled with oil separate from the oil in the main transformer tank. This tap changer compartment shall be sealed from the main transformer tank so there can be no transfer of oil between the two and shall have the capability of being completely drained or filled, under vacuum, without dropping the oil level in the main transformer

tank. The LTC compartment shall be capable of withstanding full vacuum in the main tank without damage to the LTC compartment or components. This compartment shall be provided with the following accessories:

a. Non-corrosive hinged doors with oil-resistant gaskets and stainless-steel hinges and hardware.

b. A combination oil drain, sampling and lower filter press valve, and an upper filter press valve.

c. An automatic reset pressure relief device shall be furnished for relief of excessive internal pressure. The design of this device shall minimize discharge of oil and exclude the weather after operation and shall be equipped with alarm contacts.

d. Weatherproof cabinet breather

e. Magnetic liquid level oil gauge with low level alarm contacts.

12. The 120 VAC reference voltage regulating relay will be obtained from an Owner-supplied voltage transformer in the substation, and the power required to drive the LTC mechanism will be obtained from the auxiliary power transformer. All internal wiring required to interface with external wiring shall be terminated on terminal blocks. Each individual function shall be supplied by a separate circuit which shall be individually protected by an approved circuit breaker device. Outline drawings shall completely indicate internal and external wiring.

2.07 THERMAL PROTECTION

A. Cooling equipment shall be provided for the transformer and shall be fully automatic, operating in response to winding or top-level oil temperature, the means being optional with the manufacturer. Manually operable switches connected in parallel with the automatic control contacts shall be included and may be in the control compartment. Auxiliary cooling equipment shall be complete up to incoming supply terminal box. All equipment shall be coordinated for operation at single phase, 120 or 240 VAC.

B The cooling equipment shall be fabricated so that water cannot collect on the outside, oil flow will not be impeded inside, and maintenance painting will be facilitated.

C The transformer shall be provided with a sufficient number of radiators to provide adequate cooling with average ambient air temperature of 30°C, with 12 hours at 40° C, over a 24-hour period.

1. The radiator shall be attached to flanges welded into the case wall and the joints shall be made tight by means of suitable gaskets.
2. Radiator metal wall thickness shall not be less than 18 gauge.
3. Radiators or groups of radiators shall be attached to the flanges welded to the tank wall by means of approved valves, (pressure seal type butterfly or flapper valve type) which may be used to isolate or remove sections of radiators without decreasing the capacity of the transformer by more than one-sixth (1/6) at any stage of cooling.
4. Radiators shall be provided with drain plugs.
5. Radiators shall be galvanized after fabrication. Radiators shall be painted as described in Exhibit A, Article 2.03.

D. The cooling and control equipment shall be self-contained for the unit. Two Stages of auxiliary cooling shall be provided, with each of the two auxiliary stages subsequently increasing the transformer rating by a minimum of 33.33% over the

Base rating. Control equipment for the cooling equipment shall be furnished and shall be fully automatic, in operation, with facilities provided for continuous manual run control, if desired. In the fully automatic operation mode, the control equipment shall be designed to start and stop the fans, and/or oil pumps, as the oil or transformer winding temperature requires. To equalize wear, selection of the cooling fan bank which operates on first stage shall be manually selectable by the Operator. The control equipment shall be supplied as a unit, complete with all necessary protective devices and accessories. Each fan circuit shall be individually protected. Fans supplied as cooling equipment which have blades that are riveted to their rotating base mount are not acceptable. However, cast aluminum blades are acceptable. Fan blades shall be encased in an OSHA approved safety screen. The number of fans provided in each cooling bank shall be as required to meet the required design cooling capacity for the stage, plus an additional 10% of the cooling bank's design rating.

E. An additional fan starting contact shall provide for local/remote control of air-cooling equipment.

F. A dial type "Thermal Load" indicator gauge shall be furnished and attached to the tank at eye level which will indicate the percent thermal loading of the transformer at all times. In addition, the "Thermal Load" indicator shall be equipped with a red maximum hand (re-settable locally) which will show highest condition of thermal loading which occurred since last observed and reset. Auxiliary contacts completely wired to terminal blocks shall be provided to telemeter 55°C and 65° oil temperatures and operation of first and second stage cooling equipment.

G. The circuit from the "Thermal Load" indicator current transformer to the "Thermal Load" indicator gauge shall be brought through a test switch in the transformer control cabinet. This test switch shall be capable of shorting the "Thermal Load" indicator current transformer circuit before it terminates at the "Thermal Load" indicator gauge giving warning to short out the "Thermal Load" current transformer via the test switch before removing the cannon plug from the "Thermal Load" indicator gauge.

H. If pumps are provided as part of the cooling system, necessary valves and fittings shall be installed to make it possible to remove a pump for service and continue to operate the transformer at a load level no less than 133% of its self-cooled rating.

2.08 TRANSFORMER PROTECTION

A. Surge Protection:

1. Three Station-Class Gray surge arresters, G.E. Co. 180 KV "Tranquell", Cat. No. 9L11XPA180, or approved equal, shall be mounted adjacent to the high voltage bushings; three Station-Class Gray G.E. Co. 60 KV surge arresters "Tranquell", Cat. No. 9L11XPA060, or approved equal, shall be mounted adjacent to the low voltage bushings. Surge arrester mounting brackets shall be an integral part of the sides of the transformer tank or the double wall enclosure. Rating of arresters shall be fully coordinated with BIL level of the transformer.

2. A ¼" x 1 ½" copper bus arrangement shall be provided as a means to ground surge arresters to ground pads at the base of the tank. One bus arrangement for each set of arresters shall be secured to tank wall or structural members with removable fasteners.

B. Winding Thermal Protection:

Thermal protection shall be provided consisting of one 3-element thermal load indicating relay calibrated to operate on duration and magnitude of the transformer winding temperature (ANSI Device 49). This relay shall be equipped with one set each of four sequence contacts set for controlling the fans as required for alarm, shall automatically operate a remote annunciator when winding temperature approaches the maximum safe operating value, and will be used to alarm annunciator and lock out the circuit breakers if this temperature is exceeded.

An additional fan starting contact shall provide for automatic control of air-cooling equipment. The thermal load relay shall include a remote reset switch in the transformer control cabinet.

C Fault Detection:

1. The transformer shall be provided with a Qualitrol 900 or equivalent oil-operated fault pressure relay (ANSI Device 63) responsive to rate of rise of pressure. Contacts shall be rated for 125 Vdc operation and shall be suitable to operate a remote auxiliary seal-in relay.

2. The oil-operated fault pressure relay shall be furnished and properly installed in strict accordance with the manufacturer's recommendations. A suitable valve shall be supplied between the tank and the relay.

3. Provide a certified test report to demonstrate that the relay has been fully tested and is properly calibrated. A copy of the test report shall be included with the transformer test reports.

4. Pressure relief devices shall be provided for the transformer main tank and LTC compartments. Suitably sized pressure relief devices manufactured by Qualitrol shall be supplied with local operation indication and output contacts suitable for alarm of operation.

2.09 CURRENT TRANSFORMERS

A. Current transformers shall be designed for the appropriate classification accuracy rating. The basic impulse insulation level, multi-ratio current rating, secondary taps, continuous rating, and short-time current ratings shall be in accordance with IEEE C57.13.

B. Unless noted, all current transformers shall be multi-ratio, five (5) tap minimum, with industry standard tap configuration and ratios. All taps shall be brought out

and terminated on shorting type terminal blocks located in the control compartment. ANSI classification shall be as noted.

Note: Current transformer ranges may be adjusted by Owner at or prior to the time of shop drawing review at no additional cost to the Owner.

C. C.T.'s required for autotransformer:

1. High Voltage Bushing – One per bushing (three) 1200:5 MR (C800) and one per bushing (three) 2000:5 MR (C800). (Installation Note: The 2000:5 MRCT shall be the bottom set). All current transformers shall be of Relaying Accuracy Class with a Thermal Rating Factor of 2.0.

2. Low Voltage Bushing - One per bushing (three), 1200/5 MR (C800) and two per bushing (six), 2000:5 MR (C800). (Note: The 1200:5 MRCT shall be the bottom set and shall be thermally rated for continuous 10 amperes secondary). All current transformers shall be of Relaying Accuracy Class with a Thermal Rating Factor of 2.0.

3. HOXO Neutral Bushing - One per bushing 2000:5 MR (C800). The current transformer shall be of Relaying Accuracy Class with a Thermal Rating Factor of 2.0.

4. Tertiary Winding – Two, 2000:5 MR (C800). Each current transformer shall be of Relaying Accuracy Class with a Thermal Rating Factor of 2.0.

D. Bushing C.T. information shall be shown on separate nameplate or main nameplate and shall be per IEEE C57.13, Paragraph 6.8.

E. Polarity marks on bushing CT's shall be toward external bushing terminals.

F. The tertiary current transformers are to be located on the tertiary bushings between the Y_1 and Y_3 winding points with the polarity mark toward the Y_3 (based on tertiary winding having standard ANSI 30° lag from the high voltage winding).

2.10 BUSHINGS

A. The insulation level of line bushings shall be equal to or greater than the insulation level of the windings to which they are connected.

B. All windings leads (including the neutral) and core ground(s) shall be brought out and connected to terminal bushings. The bushings shall be designed, and terminations so made that no undue stressing of the bushings shall occur due to conductor expansion or temperature changes.

C. The bushing porcelain shall be gray glaze and manufactured by the wet process method and shall be homogenous, free from laminations, cavities or other flaws affecting its mechanical strength or dielectric qualities. The porcelain shall be well vitrified, tough, and impervious to moisture. The glazing shall be free of imperfections such as blisters or burns. High voltage bushings shall be paper-oil condenser bushings interchangeable with ANSI Standard bushings for power circuit breakers in the same voltage classes. Bushings shall be as manufactured by ABB or Lapp. (No substitutions).

D. High voltage bushings shall be located in Segment 3 and low voltage bushings shall be located in Segment 1, HOXO neutral bushing shall be located in Segment 2, per IEEE C57.12.10, Figures 7 and 8. The low voltage X2 bushing shall be on the same centerline with the high voltage H2 bushing.

E. Power factor test terminals shall be provided on all cover mounted high voltage bushings.

F. All necessary connectors and hardware shall be furnished for connecting the core ground bushings to the transformer ground.

G. Terminal stud connectors shall be provided as follows for the bushing and surge arrester studs:

High Voltage	Lapp-Doble Test Terminals, 4 hole
Low Voltage	Lapp-Doble Test Terminals, 4 hole
Neutral (HOXO)	Spade Terminals, 4 hole
Core Ground	Spade Terminals, 2 hole
Surge Arresters	Spade Terminals, 4 hole
Tertiary	Spade Terminals, 2 hole

1. On 69 KV and below, the X_1, X_2 and X_3 bushings shall be supplied with bronze Lapp-Doble test terminal stud connectors to tin plated, 4-hole flat pad, vertical take-off. (No substitutions).

2. On 230 KV bushings, the Lapp-Doble test terminal stud connectors shall be bronze to tin plated, 4-hole flat pad, vertical take-off. (No substitutions).

3. On transformers with Delta connected tertiary windings, the winding shall be brought out on four bushings; two of these bushings shall be used for external closing of the Delta as specified in Section 2.04. All necessary connectors and hardware shall be furnished for connecting neutral and/or core ground bushings to the transformer ground.

H. Bushing Ratings:

Bushings shall comply with the dimensions, performance, and test requirements of IEEE C57.19.00 and IEEE C57.19.01 and shall have ratings as follows:

Quantity/ Type	Insulation Class KV	Current Rating Ampere	BIL & Full Wave KV	Withstand 60 Sec. Dry	Withstand 10 Sec. Wet	Min. Creep Dist.-In
3 – H.V.	196	600	900	465 KV	385 KV	135
3 - H.V.	69	1600	350	160 KV	140 KV	48
3 - L.V.	15	2000	110	50 KV	45 KV	11
1 - Neut.	15	2000	110	50 KV	45 KV	11
1 - Core Ground	5	600	75	27 KV	24 KV	6

2.11 CONTROL WIRING

A. All control wiring shall be type SIS No. 12 AWG minimum, stranded copper, and shall be terminated in the control compartment on terminal strips with markings in accordance with wiring diagrams. This shall include termination of wiring for all control relays and devices, auxiliary switches, safety switches and device interconnections. Connectors shall be nylon-insulated ring tongue Burndy Type YAEV of appropriate size, (No substitutions). All conductors shall be identified by shrink fit or wrap-on sleeve with legible black characters on a white background to denote the destination terminal point of the conductor.

B. All taps from five tap multi-ratio current transformers shall be brought to shorting type terminal blocks in the control compartment.

C. Auxiliary Control Wiring

All control wire runs on the outside of the transformer shall be installed in hot dip galvanized rigid steel conduit. Drain fittings shall be provided at the lowest points and breather fittings at upper points such that all moisture that collects will be drained. Control wires may be run in the transformer bracing but must be readily accessible for maintenance. Leads to fans may be made with open cable with PVC jacket and connected to a suitable outdoor waterproof box next to the fan. Fan supply cables shall not exceed six feet in length. Stainless steel

terminal studs shall be supplied in the enclosure box so that a motor may be disconnected and repaired with all other equipment in operation.

2.12 TERMINAL BLOCKS

Wiring shall be terminated on terminal blocks clearly marked for circuit identification as follows:

A. All mechanism control wiring shall be terminated on Teledyne/Penn-Union Cat. No. 6012 terminal blocks, (No substitutions).

B. C.T. secondaries shall be terminated on Teledyne/Penn-Union Cat. No. 6006-SC shorting type terminal blocks, (No substitutions).

C. Transformer auxiliary power supply terminal blocks shall be as follows:

1. Terminal blocks for loads more than 80 amperes shall be Class 9080, Square D, Unit Construction, Type V or equal, suitable for wire range of #6 AWG-250 kc mil.

2. Terminal blocks for loads less than 80 amperes shall be Class 9080, Square D, Unit Construction, Type U or equal, suitable for lug size range of #10 - #1/0 AWG.

2.13 ANNUNCIATOR PANEL

An annunciator panel shall be installed in the transformer control cabinet. Annunciator shall be a Schweitzer Engineering Laboratories SEL-252302H100XC1XX relay shall be installed in the transformer control panel and be wired to all alarm points. All alarm points shall be properly labeled on the front of the annunciator. Programming of the SEL-2523 will be done by others.

Manufacturer: Schweitzer Engineering Laboratories
Model: SEL-252302H100XC1XX
NO SUBSTITUTIONS.

2.14 NEUTRAL GROUND CONDUCTOR

The transformer neutral will be connected to the substation ground grid. A minimum of two insulated mounting supports shall be provided on the transformer tank. The mounting supports shall be secured to the transformer tank and be provided with copper conductor clamps suitable for securing conductors up to 1000 kc mil.

2.15 TRANSFORMER ACCESSORIES

Other accessories shall include, but not be limited to, the following:

A. Control Cabinet:

1. A.C. Power

a. Power Supply Switch (Source by Owner).
b. Light and G.F.C.I. Convenience Outlet.
c. Space Heater and Switch.

B. Gauges shall be equipped with ungrounded alarm contacts suitable for 125 VDC operation.

C. Magnetic liquid level oil gauge with low level alarm contacts. Qualitrol only.

D. Combination Pressure - Vacuum gauge with alarm contact

E. Dial type thermometer to indicate liquid temperature, attached to the tank at eye level, closed oil well design, with maximum reading pointer (re-settable locally) and alarm contacts. This gauge is in addition to the thermal load indicator of Article 2.07. Qualitrol only.

F. Winding temperature gauge, with heater and thermometer bulb mounted in a leakproof well, calibrated to indicate the transformer's hot spot winding temperature. Qualitrol only.

G. Gas sampling valves.

H. Automatic reset pressure relief devices on the LTC and main tank covers with alarm contacts. To be designed for minimum discharge of oil and to exclude air and water after opening.

I. Upper filter press connections with 2-inch (min.) valve.

J. Lower filter press connections with 2-inch (min.) valve and sampling device.

K. Drain valves.

L. A minimum of two copper-faced ground pads, diagonally opposite with two 0.50-13 tapped holes on 1.75-inch centers equipped with clamp-type grounding connectors equal to Anderson Electric Co. No. SWH-025-B for No. 2/0 AWG-250 kc mil copper cable.

M. Conduit entrance provisions, current transformer connections including wiring, conduit, and test switches; controls, accessories and auxiliaries, and related wiring as specified elsewhere in this specification.

2.16 SPARE PARTS

The Contractor shall furnish (2) complete power transformers as described above, plus a complete set of spare parts as follows:

A. Three (3) low voltage (69KV) bushings

B. One (1) core ground bushing

C. Two (2) sets of gaskets

D. Four (4) sets low voltage fuses for LTC

E. Two (2) 1-quart cans of touch-up paint for base coat

F. Two (2) 1-quart cans of touch-up paint for finish coat

G. Four (4) High voltage (230KV) surge arresters.

H. Four (4) Low voltage (69KV) surge arresters.

PART 3-EXECUTION

3.01 FACTORY TESTS

A. The following transformer tests shall be performed. The following standards shall be used for completing the test: IEEE C57.12.00, IEEE C57.12.10, IEEE C57.12.90, IEEE C57.91, IEEE C57.98, IEEE C57.109, IEEE C57.113 and IEEE C57.131.

1. Resistance measurement of all windings on the full winding tap position of each unit. Use 2,500 V test equipment and correct to 20°C temperature reference.
2. Ratio tests on the rated voltage connection and on all tap connections.
3. Polarity and phase relation tests on the rated voltage connection.
4. No-load (excitation) loss at rated frequency and at 100 percent and 110 percent of rated voltages.
5. Total loss at rated self-cooled KVA and rated forced-cooled KVA(s) at rated voltages and frequency.
6. Fan and/or pump power requirements for each rating.
7. Regulation at unity power factor and 80 percent power factor lagging.
8. Percent impedance, resistance, and reactance on rated self-cooled KVA base.
9. Impedance and load loss at rated current and rated frequency on the rated voltage connection and at the tap extremes of each unit.

10. Exciting current at rated frequency in percent at 100 percent and 110 percent of rated voltages.

11. Hottest spot temperature rise at rated self-cooled KVA and forced-cooled KVA(s).

12. Temperature rise test data shall be on minimum and maximum ratings or may be given from a "thermal duplicate" unit.

13. Applied voltage tests.

14. High potential and induced voltage tests - ANSI Standard.

15. Bushing Tests: Power factor of bushing shall be furnished both as individual units and as installed in tank.

16. Terminal bushing test and flashover voltages -ANSI Standard.

17. IEEE C57.113 Partial Discharge (Corona) Tests: Test on completed unit based on one hour at 150% of maximum operating voltage to demonstrate satisfaction of a guaranteed level of 150 micro-volts.

18. Audible Sound Level Tests: Results of sound level tests shall be provided on each unit at the self-cooled rating and all forced-cooled ratings.

19. Resistance Measurement of Insulation: Use 5KV test equipment and correct to 20°C temperature reference to establish basis for future comparisons.

    - Measurements shall be made between windings and all windings and ground.

20. Insulation Power Factor: Record data shall state test method and specify style and serial number of test equipment and shall include temperature reference to establish basis for future comparisons. Tests shall be performed using a minimum test voltage of 10 kV. Results shall include separate values for CH, CL, and CHL. These values shall not be combined, and a value above 0.5%, corrected to 20°C, will not be acceptable.

21. The tests shall include a quality control impulse series in accordance with IEEE C57.98. The leakage impedance measured after the test series shall not differ from that measured before the test series by more than two percent of its former value.

22. Fault Pressure Relay Test: A report for the fault pressure relay shall be obtained from the original manufacturer. The test report shall verify that the relay has been fully tested at the manufacturer's test laboratory and that it is properly calibrated. A copy of this test report shall be included with the transformer test report.

23. Current transformer tests, (ratio, saturation and excitation, polarity) with curves.

24. A Sweep Frequency Response Analysis (SFRA) test shall be performed on the transformer at the factory prior to shipment. SFRA test equipment and testing procedures, as recommended by Doble Engineering, shall be used for the tests. This test shall be performed with the transformer main tank filled with oil and all bushings installed. Transformer radiators may not be installed for this test. Response curves measured shall be provided to the Owner for comparison with subsequent SFRA field tests taken after the unit has been installed at the final substation site (See Section 16-000, 3.04G).

B. Owner reserves the right to witness testing. The Contractor shall notify Owner, in writing, no less than 3 weeks prior to the scheduled starting date of the factory tests to allow Owner to witness testing. Testing shall take place within the United States of America to prevent international travel for personnel.

C. The Contractor shall notify Owner of any unusual event or damage occurring during the fabrication of the transformer and of all tests which do not meet the specified standard values. Owner reserves the right at its option to inspect such damages or test failures. Corrective measures to overcome such damage or failure shall be subject to acceptance by Owner

3.02 CERTIFIED FACTORY TEST REPORTS

The Contractor is expressly advised that certified test reports on the unit(s) delivered must include values to permit determination of No Load and Load Losses and other power requirements. In the event such losses or requirements exceed the values guaranteed at time bids will be assessed as liquidated damages an amount to be determined as follows:

A. No Load Losses	For each kW or fraction thereof that actual test losses exceed guaranteed losses, the Contractor will be assessed amount computed based on $9,171 per kW.
B. Load Losses	For each kW or fraction thereof that actual test loss exceeds guaranteed losses, the Contractor will be assessed an amount computed based on $2,943 per kW.
C. Power Requirements For Cooling Equipment	For each kW or fraction thereof that actual power requirements as established by test exceeds the approximate power requirements furnished with the bid, the Contractor will be assessed an amount computed based on $9,171 per kW.

3.03 AUXILIARY POWER TRANSFORMER

A. A single phase, 150 KVA, 60 Hertz auxiliary power supply transformer shall be supplied. Connections from the main autotransformer tertiary winding shall be

brought through the main tank by suitable oil-filled bushings into a separate fuse compartment. This compartment shall totally enclose two suitable current limiting SPST fuse switches and suitable connections to the auxiliary transformer. The auxiliary transformer shall be bolted to the fuse compartment in such a manner that the auxiliary transformer can be easily removed if repairs are required.

B. This compartment shall have a hinged door with suitable door stops and with a latch-type handle that is lockable. Breakers (see Section 3.03G) or surge suppressors (see Section 3.03 I) shall NOT be mounted in this compartment.

C. The high voltage winding of the auxiliary power supply transformer shall be connected ungrounded on the high voltage side. The low voltage side shall be connected single-phase 240/480 volts with the center tap grounded. The low voltage bushings and the leads to the breakers in the control cabinet shall be totally enclosed but constructed such that the auxiliary transformer can be easily removed. A disconnect switch or other visual means shall be provided so that field personnel at ground level can be positive that voltage is not supplied to the auxiliary power supply secondary from alternate power sources. The Contractor shall determine if surge arresters are required to protect the primary of the auxiliary transformer. Low voltage transformer leads shall be terminated on a suitable terminal strip, in the control cabinet, with lug connections for the Owner to terminate cable leads to be installed between the control cabinet lugs and an externally located and mounted, station transfer switch provided by the Owner.

D. The auxiliary transformer details including ratings, winding and connection diagram, polarity and vector phasing diagrams shall be included with the approval drawings.

E. The auxiliary power supply ground shall be connected to ground separately from the main transformer tank ground.

F. Magnetic air circuit breakers having front adjustable magnetic trip units shall be supplied on the low voltage side. The breakers shall be rated 600 VAC with a minimum of 65,000 amperes asymmetrical interrupting capacity at 240 VAC. Suitable auxiliary transformer impedance, breaker frame sizes, ampere ratings, and

coordination with primary current limiting fuses shall be determined by the Contractor. In sizing these breakers, consideration shall be given to ambient temperature. Heaters in the cabinets plus the hot wires connected in parallel shall be terminated in an appropriate type of multiple conductor terminal lug such as the Burndy Type Q2A or Q3A connector. Under no circumstances shall two or more cables be terminated in any type of terminal connector not specifically designed for such. i.e., Burndy Type QA, QQA or equivalent. Breakers must be coordinated such that a fan or motor fault does not trip the main breaker but rather trips the breaker feeding the faulted circuit, so far as possible with this type of breaker.

G. Surge suppressors shall be supplied for the 240/480-volt secondary windings and shall be General Electric Tranquell Model TD240S2050RMP or approved equal. Device shall be rated at 550 MCOV minimum for 480V L-L and 275 MCOV L-Gnd.